Mathematics: Discipline Specific Elective (DSE) Course -1

Any *one* of the following:
DSE-1 (i): Statistics
DSE-1 (ii): Discrete Mathematics

DSE-1 (i): Statistics

Total Marks: 100 (Theory: 75 and Internal Assessment: 25)
Workload: 5 Lectures, 1 Tutorial (per week) **Credits:** 6 (5+1)
Duration: 14 Weeks (70 Hrs.) **Examination:** 3 Hours.

Course Objectives: The course aims at building a strong foundation of theory of statistical distributions as well as understanding some of the most commonly used distributions. The course also aims to equip the students to analyze, interpret and draw conclusions from the given data.

Course Learning Outcomes: The course will enable the students to:

i) Determine moments and distribution function using moment generating functions.
ii) Learn about various discrete and continuous probability distributions.
iii) Know about correlation and regression for two variables, weak law of large numbers and central limit theorem.
iv) Test validity of hypothesis, using Chi-square, F and t-tests, respectively in sampling distributions.

Unit 1: Probability, Random Variables and Distribution Functions
Sample space, Events, Probability Classical, Relative frequency and axiomatic approaches to probability, Theorems of total and compound probability; Conditional probability, Independent events, Baye's Theorem; Random variables (discrete and continuous), Probability distribution, Expectation of a random variable, Moments, Moment generating functions.

Unit 2: Discrete and Continuous Probability Distributions
Discrete and continuous distribution, Binomial, Poisson, Geometric, Normal and exponential distributions, Bivariate distribution, Conditional distribution and marginal distribution, Covariance, Correlation and regression for two variables, Weak law of large numbers and central limit theorem for independent and identically distributed random variables.

Unit 3: Sampling Distributions
Statistical inference**:** Definitions of random sample, Parameter and statistic, Sampling distribution of mean, Standard error of sample mean; Mean, variance of random sample from a normal population; Mean, variance of random sample from a finite population; Chi-square distribution, F distribution and t distribution, Test of hypotheses based on a single sample.

References:

1. Devore, Jay L., & Berk, Kenneth N. (2007). *Modern Mathematical Statistics with Applications*. Thomson Brooks/Cole.
2. Miller, Irvin & Miller, Marylees (2006). John E. Freund's: *Mathematical Statistics with Applications* (7th ed.). Pearson Education, Asia.

Additional Readings:

i. Hayter, Anthony (2012). *Probability and Statistics for the Engineers and Scientists* (4th ed.). Brooks/Cole, Cengage Learning.
ii. Mood, Alexander M., Graybill, Franklin A., & Boes, Duane C. (1974). *Introduction to the Theory of Statistics* (3rd ed.). McGraw-Hill Inc. Indian Reprint 2017.
iii. Rohtagi, Vijay K., & Saleh, A. K. Md. E. (2001). *An Introduction to Probability and Statistics* (2nd ed.). John Wiley & Sons, Inc. Wiley India Edition 2009.

Teaching Plan (DSE-1 (i): Statistics):

Week 1: Sample space, Events, Probability Classical, Relative frequency and axiomatic approaches to probability, Theorems of total and compound probability.
[1] Chapter 2 (Sections 2.1 to 2.3).

Week 2: Conditional probability, Independent events, Baye's theorem.
[1] Sections 2.4, and 2.5.

Week 3: Random Variables, Discrete and continuous random variables, Probability distribution functions discrete random variables, p.m.f, c.d.f, Expectation, Moments, Moment generating functions of discrete random variables.
[1] Chapter 3 (Sections 3.1 to 3.4).

Week 4: Probability Distribution functions continuous random variables, p.d.f, c.d.f, Expectation, Moments, Moment generating functions of continuous random variables.
[1] Sections 4.1, and 4.2.

Week 5: Discrete distribution**:** Binomial distribution and its m.g.f., Discrete distribution**:** Poisson and its m.g.f.
[1] Chapter 3 (Sections 3.5, and 3.7).

Week 6: Geometric distribution, Continuous distribution**:** Normal and its m.g.f.
[1] Chapter 3 (Sections 3.2, and 3.6, excluding negative binomial distribution)
[1] Chapter 4 (Section 6.5)

Weeks 7 and 8: Exponential distribution and its "memoryless" property, Bivariate distribution, conditional distribution and marginal distribution, Covariance**,** Correlation and regression.
[1] Chapter 4 (Section 4.3 Pages 193 to 196), and Chapter 5 (Sections 5.1 Exclude more than two variables, 5.2, and 5.3 omit bivariate normal distribution)

Week 9: Weak law of large numbers and central limit theorem for independent and identically distributed random variables.
[1] Chapter 6 (Section 6.2).

Weeks 10 and 11: Definitions of random sample, Parameter and statistic, Sampling distribution of mean, Standard error of sample mean, Mean, variance of random sample from a normal population, Mean, variance of random sample from a finite population.
[2] Chapter 8 (Sections 8.1 to 8.3).

Week 12: Chi-square distribution, t- distribution and F- distribution.
[1] Chapter 6 (Section 6.4).

Weeks 13 and 14: Test of hypotheses based on a single sample.
[1] Chapter 9 (Sections 9.1 to 9.4).

Facilitating the Achievement of Course Learning Outcomes

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
1.	Determine moments and distribution function using moment generating functions.	(i) Each topic to be explained with examples. (ii) Students to be involved in discussions and encouraged to ask questions. (iii) Students to be given	• Student presentations. • Participation in discussions. • Assignments and class tests. • Mid-term
2.	Learn about various discrete and continuous probability distributions. Know about correlation and		

	regression for two variables, weak law of large numbers and central limit theorem.	homework/assignments. (iv) Students to be encouraged to give short presentations.	examinations. • End-term examinations.
3.	Test validity of hypothesis, using Chi-square, F and t-tests, respectively in sampling distributions.		

Keywords: Bayes theorem, Binomial, Poisson, Geometric, Normal and exponential distributions, Central limit theorem, Chi-square distribution, F-distribution and t-distribution, Correlation and regression for two variables, Moments and moment generating functions, Weak law of large numbers.